Do adult learners personal characteristics predict their learning outcomes and use of annotation and social navigation services in a CSLE?

Petri Nokelainen
Miikka Miettinen
Pekka Ruohotie
University of Tampere, Finland

Abstract

This study explored the relationships between learning outcomes, actions and motivational, learning strategy and social ability profiles in a custom made computer-supported learning environment (CSLE) prototype. The system offered three types of services: 1) Tools that support the use of learning resources; 2) Tools that enable flexible and multifaceted peer-to-peer interaction; 3) Tools that increase awareness of other user’s actions. Results showed that all motivational factors were directly or indirectly positively related to learning outcomes. Also self-reported resource management skills and preference for learning by doing were directly positively related to learning outcomes. Both time spent in the CSLE and use of awareness increasing tools were found to be positively related with learning outcomes. Use of social navigation tools in the CSLE was positively strongly related to self-reported group work abilities.

Introduction

In this study, we investigated if adult learners' self-reported learning motivation, learning strategies and social abilities are related to their learning outcomes and actual use of synchronous and asynchronous tools in a computer-supported learning environment (CSLE). The system featured a search engine with a document pool together with annotation, discussion and social navigation tools. Annotation tool allowed participants to highlight and comment (add context specific information) online course material (HTML – documents). Social navigation tool allowed them to see each others position in the course document space, for example, to determine what document other learner is currently reading.

We formulated the following research questions: 1) Are differences in the adult learners' profiles statistically related to differences in their learning outcomes?; 2) Are the adult learners' actions in the CSLE during the course related to their learning outcomes?; 3) Are the adult learners' actions in the CSLE related to differences in their profiles?
Literature review

Students' participatory skills are essential in learning processes. Worldwide scenarios stress the social nature of learning, indicated by concepts such as co-operative learning, collaborative problem-solving, sharing and promotive interaction. Social perspective theories give importance to developing organizational cultures towards more co-operative knowledge creations. The demands of learning, in the future, emphasize teamwork and networking as important tools for getting people closer together. Learning is a social practice, along with its cognitive and emotional nature. (Nokelainen, Niemi & Launonen, 2003.) Encouraging and participatory learning culture is also needed in virtual communication as learning also has a social nature. Knowledge creation is a social process and students need social readiness, for example participatory skills for co-operation and sharing.

Computer-supported collaborative learning (CSCL) has now been the work horse of distance learning courses for well over decade. The traditional interaction tools that generic systems (e.g., Moodle, WebCt, FLE and Blackboard) provide, include, for example, chat, email and news group messaging. Such a limited interaction tool palette easily guide teachers to design structured learning material. Learner’s role in these systems is mainly to interact with the material teacher has prepared for the course.

However, there are systems that provide more sophisticated tools that enable collaborative knowledge building (KB) or knowledge construction (KB), for example, CSILE/Knowledge Forum (Bereiter & Scardamalia, 2003). Such systems often provide asynchronous (e.g., Kukakuka, see Suthers & Xu, 2002) or synchronous (e.g., EDU CO, see Kurhila, Miettinen, Nokelainen & Tirri, 2002a) visual cues (Mayes & Fowler, 1999).

Social Navigation
The CSLE applied in this study is based on our previous research with EDU CO (Kurhila et al., 2002a), EDUCOSM (Miettinen, Kurhila, Nokelainen, Floréen & Tirri, 2005) and OurWeb (Miettinen, Kurhila, Nokelainen & Tirri, 2006) systems. The new system features a search engine with a document pool together with annotation, discussion and social navigation tools.

Social navigation is enabled with a semi-transparent graphical view, which floats in the browser window and shows the presence and location of the users in real time. Documents are portrayed as sheets of paper within clusters of related material, and the users appear around the documents as dots. Whenever somebody moves from one
document to another, the corresponding dot jumps to the new location. Documents and users can be identified by placing the mouse pointer over the respective icon, which shows the title of the document or the name of the user as a tooltip. Clicking a document icon opens the corresponding page, and clicking a dot opens the instant messaging tool. According to previous research, availability of social navigation tools reduce the learners’ self-reported cyber loneliness and encourage them to spontaneous collaboration (Erickson & Kellogg, 2000; Gutwin & Greenberg, 2002; Kurhila et al., 2002).

Annotation
Two different types of annotations were supported in the system: highlights and comments. Highlights can be applied to marking important parts of the text, analogously to the way people underline text on paper. In practice, adding a highlight involves selecting a fragment of text with the mouse and clicking a button in a small toolbar that appears near the selection. Comments are added the same way, except that the user types the input in a popup window. A comment appears as a tooltip when the mouse pointer is placed on top of the commented text fragment. If several comments are attached to the same text, they appear one after another as a dialogue.

Our motivation to include annotation in the CSLE used in this study is based on Marshall’s (1997) finding that underlinings in books are useful to subsequent readers. Further, according to Mayer (2002), deeper learning occurs when key steps in the interactivity are ‘signaled’ rather than non-signaled. Research has shown that combining signaling together with concrete graphical organizers improves various learners learning (Mautone & Mayer, 2007). Signaling is directly related to the first part of annotation, ‘highlighting’ of selected text sequences. Previous research also suggests that an easy-to-use annotation tool promotes asynchronous communication activities and helps to create a constructive learning atmosphere for the course (Nokelainen et al., 2005).

Method

Sample
The sample consisting of fourteen adult learners (ten females and four males, age median 43 years) was collected from a university level applied statistics course between October 2007 and March 2008 (http://www.uta.fi/aktkk/ammkl32). During the course, participants had 40 hours face-to-face lectures and exercises, and 120 hours distance learning in the CSLE. Learners previously completed distance learning course number ranged from zero to 20. Their self-evaluated computer literacy (web browser, word
processor and spreadsheet) was on a good level, but both programming and statistical computing skills were poor.

**Instrument**

Abilities for Computer Assisted Learning Questionnaire III (ACALQ III) has three parts: 1) Learning motivation (12 items); 2) Learning strategies (10 items); 3) Social abilities (12 items). First two ACALQ III parts are based on the work of Ruohotie and Nokelainen (2000), the third scale is based on Tirri and Nokelainen (2008) and Nokelainen et al. (2003).

The learning motivation part consists of three sections: 1) Value section; 2) Expectancy section; 3) Affective section. The value section has three subscales: 2) Intrinsic goal orientation; 2) Extrinsic goal orientation; 3) Meaningfulness of study. The expectancy section consists of two subscales: 4) Control beliefs; 5) Self-efficacy. The affective section includes one component: 6) Test anxiety. The learning strategy part consists of four sections: 1) Metacognition in learning; 2) Metacognition in practice; 3) Learning by doing; 4) Resource management. The social ability part consists of six sections: 1) Interpersonal abilities; 2) Intrapersonal abilities; 3) Self-concept; 4) Self-esteem; 5) Place oneself (empathy); 6) Group work abilities. Theoretical structure and the items of the questionnaire are reported in detail elsewhere (Nokelainen & Ruohotie, 2004).

**Procedures**

In the beginning of the course, students were profiled with the ACALQ III. In addition, we produced a set of controlling variables by measuring their initial level of statistical knowledge with an online questionnaire and testing their working memory capacity and computer screen (flat panel) text reading speed with a computer-based application. Although the sample size was small, the results pointed out that older participants scored lower in working memory capacity and computer screen reading test than their younger peers, \( \chi^2(2, 14) = 4.639, p = .098 \). Gender was not related to controlling variables.

During the course, students produced two learning outcomes. Firstly, a scientific essay as distance learning task in the CSLE. Secondly, a statistical computing exercise in the last face to face meeting. Both learning outcomes were evaluated on a scale from 1 (poor) to 5 (excellent). The CSLE accumulated fine-grained data on the actions of the students. Several interesting questions can be addressed by analyzing the amount of time invested in various kinds of activities (reviewing lecture slides, skimming and reading instructional material, searching for research papers, skimming and reading research papers,
annotating, discussing,...). The system monitored the scrolling of pages in the browser window, and was able to detect periods when the user was not working actively.

**Statistical Analyses**

Bayesian modeling allows the use of nominal (e.g., gender) and ordinal (e.g., Likert-scale) variables in the analysis. Further, it also analyzes both linear and non-linear dependencies between observed variables and assumes no minimum sample size for technically robust calculations. (Nokelainen, Silander, Ruohotie & Tirri, 2007.)

We applied in this study Bayesian Dependency Modeling (BDM), which predicts the most probable statistical dependency structure between the observed variables (Myllymäki, Silander, Tirri & Uronen, 2002). It visualizes the result in a form of a Bayesian network (BN) allowing user to probe the model by adjusting the values of all variables and examining the effects to other variables included in the best model (Heckerman, Geiger & Chickering, 1995).

**Findings and discussion**

**Research Question 1: Are differences in the adult learners’ profiles statistically related to differences in their learning outcomes?**

The first research question investigates if learning motivation and learning strategies are related to learning outcomes. Research literature suggests that higher motivation and learning strategy profile levels are connected to higher learning outcomes (Kettanurak, Ramamurthy & Haseman, 2001). We controlled the analysis with participants age (range from 30 to 54 points; M = 42.8; SD = 7.5) and initial statistics test score (range from 0 to 26 points; M = 15.4; SD = 2.2).

Results showed that three out of six of the motivational factors (‘Extrinsic goal orientation’, ‘Meaningfulness of studies’ and ‘Self-efficacy’) were positively related to the first learning outcome in our model, a scientific essay that was graded on a scale from 1 (lowest) to 5 (highest). In practice, this means that learners who self-reported that they liked to study demanding subjects (despite the possibility of getting low grades), believed in their ability to learn even the most difficult subjects during their studies and expected to get the highest grades from the most demanding courses, did get higher grades from a distance learning task in applied statistics than their peer learners.
Two motivational factors (‘Self-efficacy’ and ‘Test anxiety’) were related to the second learning outcome in the model, a statistical computing task that was graded on a scale from 1 (lowest) to 5 (highest). Self-efficient students believe that they have the ability to learn the most demanding tasks. The computing test was the final examination of the course and had a 40 per cent effect on the final grade. The latter fact explains quite obviously why the last motivational factor, ‘Test anxiety’, was related to it.

Further, two motivational factors were directly related to other motivational factors and, thus, indirectly related to learning outcomes: ‘Intrinsic goal orientation’ was positively related to ‘Meaningfulness of studies’ and negatively related to ‘Test anxiety’. Both findings were expected. Firstly, people who tend to study interesting subjects thoroughly, also tend to think that studying is a meaningful task. Secondly, growth of expertise on any subject (due to amount of time and energy put into the studies) decreases fear of test situations and failure, at least to some extent.

Two dependencies were found between learning strategies and learning outcomes. Self-reported skills in ‘Resource management’ (i.e., tendency to work hard and prepare well in order to pass both interesting and uninteresting the courses) was related positively to both learning outcomes. Also, ‘Learning by doing’ factor was positively related to both learning outcomes.

Neither of the two controlling variables was statistically related to learning outcome variables. However, participant’s age was positively connected to ‘Learning by doing’ factor, that is, older participants preferred practical job-related tasks more than theoretical ones.

**Research Question 2: Are the adult learners' actions in the CSLE during the course related to their learning outcomes?**

In order to answer the second research question, learner’s actions are further classified into four activity groups according to the previously presented services in the CSLE. The first activity group contains the log file about learner’s use of annotation tools. Annotation summary variable was calculated from the following variables: 1) Highlightings (range from 0 – 80); 2) Comments (range from 0 – 9); 3) news groups messages (range from 0 – 6). The second activity group is represented with a summary variable of chat (range from 0 – 3) and email messages (0 – 1) sent by the learners. The third activity group is about social navigation. The log file in this activity group was recorded on two occasions: First, if a user pointed (or clicked) other users “dot” on a map view (i.e., seeking for personal information or instant messaging company), and second,
if a user browsed to a “occupied document” (i.e., document in the map view that one or more other learners are already reading). The summary variables values ranged from 0 to 8. The fourth activity group is represented with a summary variable that contains the overall time user has spend reading additional learning material (range from 0 to 159 minutes), scientific articles (range from 49 to 1033 minutes) and lecture slides (range from 0 to 170 minutes) in the system.

We controlled the analysis with age and initial statistics test score, and added a third one that measured participants working memory capacity and reading speed from a computer screen. The values of the third controlling variable range in this sample from 0 (poor) to 8 (excellent), \( M = 3.9, \text{SD} = 1.7 \). Analysis showed that the controlling variables were not statistically related to user actions in the CSLE or their learning outcomes.

Results showed that use of both annotation and instant messaging tools was positively related to use of social navigation tools and, quite naturally, total time spent in the system. Further, two of the activity groups had a direct positive statistical relationship to learning outcomes: First, an active use of awareness increasing tools predicted high learning outcomes. Second, the most significant predictor for high learning outcomes was the total time spent exploring learning resources in the CSLE. Only a weak indirect positive statistical relationship was observed between an active use of annotation tools and learning outcomes.

Research Question 3: Are the adult learners' actions in the CSLE related to differences in their profiles?

The third research question examined the relationships between learners’ self-rated social abilities and the use of instant messaging and social navigation tools in the CSLE. The same controlling variables were used than in the previous analysis: Age, initial statistics test score and cognitive load and reading speed test score.

Results showed that the best predictor for the active use of instant messaging tools was the use of social navigation tools. Further, use of social navigation tools in the system was positively strongly related to self-reported group work abilities and positively weakly related to ‘Interpersonal abilities’ and ‘Self-esteem’ factors.

Conclusions

First part of the results showed, in parallel with our theoretical framework, that learners' motivational profiles were positively connected to learning outcomes. Learner's self-
evaluated ‘resource management strategies’ and willingness to ‘learn by doing’ were also positively connected to learning outcomes. These findings are similar to those of our previous study with the EDUCOSM prototype (Nokelainen et al., 2005). We conclude that the results of the first research question supported the findings of an earlier study by Kettanurak and his colleagues (2001) suggesting that higher motivation and learning strategy profile levels are connected to higher learning outcomes.

Second part of the results showed that time spent in the CSLE and use of awareness increasing tools (social navigation) correlated positively with learning outcomes. Only a weak positive statistical relationship was observed between an active use of annotation tools (highlighting and commenting documents) and learning outcomes. However, our previous study (Nokelainen et al., 2005) showed a strong positive correlation between quality of annotations in the prototype system and the final grade in the same applied statistics course, $r(50) = .77, p < .001$. We recommend on the basis of our current and previous research findings use of annotation tools in CSLE’s. However, Marshall’s (1997) finding that annotation (she studied underlining of library books, i.e., ‘signaling’) would be helpful for peer learners was not supported by the results of neither our current nor previous study (Nokelainen et al., 2005). The results of our previous study indicate that self-made annotations were experienced to be more useful for learning than peer-made annotations. We conclude that this area would benefit from further investigations.

Third part of the study analyzed the statistical relationships between self-reported social abilities and actions in the CSLE. Results showed that those learners, who reported high level of social abilities, were the most active users of the social navigation tools provided by the system. When we connect the results of the second (active use of social navigation tool is positively connected to successful learning outcomes) and third (high social ability level is positively connected to the active use of social navigation tool) part, we notice that high social ability level is indirectly positively connected to successful learning outcomes.

References


